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Reply to: 3420 Date: June 7, 1994

Subject: Douglas-fir Tussock Moth Monitoring In Arizona, 1993

To: Forest Supervisors, Tonto National Forest and Coconino National Forest

Enclosed is an evaluation of Douglas-fir Tussock Moth (DFTM) based on the results of the 1993 survey in central Arizona. In 1992, an early warning system to detect incipient outbreaks of the Douglas-fir tussock moth was installed in several locations on the Tonto National Forest were DFTM has been known to occur historically. These locations include the Sierra Ancha and Pinal Mountains near Globe and the Mogollon Rim near Payson. In 1993, a new location was added along the Mogollon Rim just south of Baker Butte on the Coconino National Forest. Douglas-fir Tussock Moth is an important defoliator of white fir and Douglas-fir in the inland west.

Trap results from 1992 indicated that relatively high populations of DFTM existed in the Pinal Mountains, Globe RD, while endemic levels were detected in the Sierra Anchas and along the Mogollon Rim near Payson. These results suggested that visible defoliation might be detected in the Pinals in the summer of 1993.

Due to high population levels in the Pinals in 1992, a survey was conducted June 1993 to sample larval populations (see our 3410 letter June 15, 1993). Results of that survey indicated that high population levels were still present in the Pinals with low populations in the Sierra Anchas. Visible defoliation was predicted in the Pinals for the summer of 1993.

Pheromone traps were installed at all locations during July, 1993. It was noted at that time that DFTM populations had apparently collapsed in the Pinals. From the appearance of the foliage, the collapse must have happened not long after our larval survey in June as the amount of visible defoliation was about the same as we had observed at that time. Trap results from 1993 indicate that low population levels are present at all locations. However populations may be on the rise in the Sierra Anchas.

If you have any questions or would like additional copies of this report please contact Jill Wilson, at the Arizona Zone Office in Flagstaff, (602) 556-2074, DG: J.Wilson:S28L02A.

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DOUGLAS-FIR TUSSOCK MOTH MONITORING IN ARIZONA, 1993

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ABSTRACT

In 1992 an early warning system to detect incipient outbreaks of the Douglas-fir Tussock moth was installed at several locations in central Arizona. Results of this survey indicated that sub-outbreak population levels were present in the Pinal Mountains near Globe. Very low populations were detected in the Sierra Ancha Mountains north of Globe. No moths were trapped along the Mogollon Rim north of Payson. Early instar larval sampling conducted in June 1993 indicated that populations were still high in the Pinals and visible defoliation was anticipated later that summer or in 1994 if populations continued to increase. Trap results from 1993 however suggest that populations have since dropped in the Pinals, averaging 13.2 moths per trap, and remain low at other monitoring locations on the Tonto National Forest with an average of 3.4 moths per trap from Washington Park, 7.1 and moths per trap in the Sierra Anchas. No moths were trapped near Baker Butte on the Coconino National Forest. Comparing 1992 and 1993 trap results suggests that populations have declined in Pinal Mountains but may be on the rise along the Mogollon Rim and in the Sierra Anchas. Visible defoliation is not anticipated in any of the monitoring areas in 1994. Future Forest Pest Management survey plans, general management considerations, and technical information on the biology, and effects for DFTM are discussed.

INTRODUCTION

Outbreaks of the Douglas-fir tussock moth, DFTM, Orgyia pseudotsugata, occur periodically in some mixed conifer forests of the Southwest. During outbreaks, defoliation of white fir and Douglas-fir can be severe.

In Arizona, there are two known historic outbreak areas, the Pinal Mountains and Sierra Ancha Mountains, near Globe on the Tonto National Forest (Lessard 1975). The last known outbreak occurred in these locales in the late 1960's and early 1970's (Lessard 1975) when 800 acres was defoliated on Baker Mountain in the Sierra Anchas and 400 acres sustained moderate to heavy defoliation on Signal Peak in the Pinals. The largest outbreak in these areas occurred in the late 1950's when 3,000 acres were defoliated on Signal Peak, and 5700 acres sustained defoliation in the Sierra Anchas. The known distribution of DFTM in Arizona also includes the Mogollon Rim, and Mt. Graham (Lessard 1975).

The DFTM is very difficult to find except during outbreaks, which can develop rapidly and with little notice. To assist with providing some advance notice of outbreaks, an early warning system was developed in the 1970's (Daterman et al 1974) and is now used throughout much of the Intermountain West. This survey system uses traps baited with a synthetic version of the female moth sex attractant or pheromone. The traps capture male tussock moths in late summer and early fall during the mating season. The number of moths caught provides an indication of the number of larvae that will be present the following spring and the potential for defoliation. When average captures exceed 25 or more male moths, visible defoliation may be expected within the next two summer seasons.

METHODS

In 1993 both pheromone traps and larval sampling were used to estimate population levels. Methods for larval sampling followed those described by Mason (1979) for lower crown sequential sampling. This method is designed for sampling first and second instar larvae. Host trees were randomly selected within the sampling area. A drop cloth was held under the distal 18 to 20 inches of each branch to be sampled and a short stick was used to rap the branch. After beating the drop cloth was examined for presence of DFTM larvae. If a larva was found, the tree was noted as infested and the sampler proceeded to the next tree. If no larva was found, the sampler continued the same process on other branches on the same tree until either a tussock moth larva was found or until a total of three branches had been examined. The number of infested trees was recorded on the sequential form (Figure 1) by adding each one to the total number of infested trees found previously. An uninfested tree was recorded by adding zero to the previous number and writing the appropriate number of sampled trees. If the cumulative total of infested trees was equal to or less than the low value in the sequential sampling plan on the form, or equal to or more than the high value, sampling was stopped and the larval density was classified as either low or suboutbreak. If the cumulative total was between the specified limits in the overhead box, no classification was made and another tree was be sampled. If larval density was not classified after 20 trees had been sampled, then the plot was classified as intermediate.

Pheromone traps and lures were provided by the Methods Application Group, Forest Pest Management, in Fort Collins, Colorado. Traps were placed in three areas in Central Arizona (Figure 2) where DFTM has been known to occur at either outbreak or endemic levels. These areas include the Pinal Mountains, Sierra Ancha Mountains, and the Mogollon Rim (near Payson). In the areas selected, mixed conifer forest species such as white fir and Douglas-fir, predominated. At each area, one or more plots were selected to place a set of traps (Figures 3-5). At each plot 5 traps were placed in a looping configuration, each trap separated from the next by a minimum of 75 feet (23 meters), as described by Daterman (1974). Traps were placed in a relatively open grown tree or at the edge of a dense thicket. Traps were hung in mid July, 1993 and recovered in May, 1994.

RESULTS AND DISCUSSION

Larval Sequential Sampling

Population levels of DFTM were classified as suboutbreak in the Pinal Mountains, Globe Ranger District at the time of sampling in June, 1993. Only first and second instar larvae were noted at the two sampling locations. Low populations were detected in the Sierra Anchas on the Pleasant Valley Ranger District. Larvae were a bit further along in development in the Sierra Anchas, with mostly second instar and some third instars observed.

Trapping

Trap captures did not exceed the 25 moth threshold at any of the monitoring locations in 1993 (Tables 1-3). Populations of DFTM apparently collapsed for unknown reasons in the Pinal Mountains, with trap catches dropping over 50 percent from 1992 (Table 4). We noticed when the traps were hung in late July that defoliation was very light, not visibly exceeding the amount we observed in June during the larval survey. Larvae were not at all abundant as they had been

in June. It appeared that something caused the populations to collapse between June and July. As in 1992, trap catches were highest in the two plots in the Pinal Mountains, Icehouse and Lower Pinal, where the overall average moth catch per trap was 13.2 moths (Table 1). Average catch was somewhat higher for the Lower Pinal plot (15.6 moths) than for the Icehouse Plot (10.8 moths). These results indicate that visible defoliation is not anticipated in this area during the 1994 summer season.

Trap catches were low in the Sierra Ancha Mountains (Table 2). Overall average trap catch for the three plots was 7.1 moths. Average catch was highest at Reynolds Creek (17.2 moths) and lowest at Workman Creek (1.2 moths). These results represent an increase over the numbers trapped in 1992 (Table 4), suggesting that populations may be increasing in this area. However, visible defoliation is not anticipated at any of these locations in 1994.

While no moths were captured at the Baker Butte site along the Mogollon Rim, an average of 3.4 moths was trapped at Washington Park (Table 3), an increase over what was reported in 1992 (Table 4). No visible defoliation is anticipated in either of these areas during 1994.

TABLE 1

Summary of male Douglas-fir tussock moths caught
in the 1993 Pheromone Trap Survey, Pinal Mountain Area

Plot Name	Location	Number of DFTM by Trap					Total	Average
		1	2	3	4	5		
Icehouse	T2S R15E S5	18	13	9	1	13	54	10.8
Lower Pinal	T2S R15E S5	18	16	10	17	17	78	15.6
					Area Total		132	
					Area Ave.		13.2	

TABLE 2

Summary of male Douglas-fir tussock moths caught
in the 1993 Pheromone Trap Survey, Sierra Ancha Area

Plot Name	Location	Number of DFTM by Trap					Total	Average
		1	2	3	4	5		
Aztec Peak	T6N R2 S27	5	4	2	1	2	14	2.8
Workman Creek	T6N R14E S33	0	1	0	1	4	6	1.2
Reynolds	T6N R14E S17	12	17	18	17	12	36	17.2
					Area Total		56	
					Area Ave.		18.7	

TABLE 3

Summary of male Douglas-fir tussock moths caught in the 1993 Pheromone Trap Survey, Mogollon Rim Area

Plot Name	Location	Number of DFTM by Trap					Total	Average
		1	2	3	4	5		
Washington Park	T12N R10E S14	0	0	7	10	0	17	3.4
Baker Butte	T6N R14E S17	0	0	0	0	0	0	0.0
					Area Total		17	
					Area Ave.		8.5	

Table 4

Average number of male Douglas-fir tussock moths caught in pheromone-baited sticky traps in central Arizona during 1992-1993

Location	Mean Number of Moths per trap per year	
	1992	1993
Pinal Mountains		
Icehouse	38.2	10.8
Lower Pinal	32.5	15.6
Sierra Anchas		
Aztec Peak	1.6	2.8
Workman Creek	0.0	1.2
Reynolds Creek	7.2	17.2
Mogollon Rim		
Washington Park	0.0	3.4
Baker Butte	-	0.0

FUTURE SURVEY PLANS

Since populations have declined in the Pinal Mountains, no larval sampling will be conducted in 1994. Pheromone traps will be placed in all the same locations as in 1993.

GENERAL MANAGEMENT CONSIDERATIONS

Management recommendations to prevent or reduce adverse impacts from tussock moth outbreaks involve four major activities: monitoring and early detection, evaluation, suppression, and prevention. Early detection can be accomplished using either pheromone traps to catch male moths or larval sampling. Populations trends can be determined by continuous annual monitoring. Determination of appropriate environmentally acceptable, economically sound

tussock moth strategies requires a good understanding of desired future conditions and resource managment objectives from a site specific and a landscape perspective.

The need to suppress a tussock moth population depends on the impact an uncontrolled outbreak is expected to have on the accomplishment of resource management objectives. Decisions for control must be based on thorough evaluation of the insect population (expected trends etc.) and the resource values at stake. A number of materials are registered for suppression of DFTM outbreaks. Some are very selective and affect only the tussock moth, others are more broad spectrum. Should the need for suppression be considered a specialist from Forest Pest Management should be consulted.

Prevention of serious outbreaks, particularly those that are outside the known range of natural variability, is the ultimate goal of pest management under ecosystem management. Unfortunately in the Southwest our knowledge of outbreak history, insect-host relations and stand dynamics is limited compared to other regions of the west. In general, outbreaks are confined to old, multi-storied stands of white fir and Douglas-fir, without a history of logging (Stoszek and Mika 1979). White fir sustains higher defoliation than Douglas-fir. Outbreaks tend to occur in lower elevations, where the amount of precipitation restricts growth of white fir. Stoszek and Mike (1979) compared a number of studies conducted in the west on relationships between stand characteristics and outbreaks and reported that in general DFTM outbreaks are associated with conditions where tree competition for moisture and nutrients may be great: ridgetops and upper slopes, poor productivity sites, and mature and overmature multistoried stands with high density, particularly of host species. Since fir growing on pine sites and fir stands growing on warm, dry sites seem most vulnerable to DFTM, one of the most effective preventive measures may be to use silvicultural treatments or prescribed fire to maintain seral pine or hardwood species in vulnerable areas.

TECHNICAL INFORMATION

Douglas-fir Tussock Moth

Introduction

The biology and effects of the Douglas-fir Tussock Moth are described in detail by Wickman et al (1975) and Brookes et al (1978). The Douglas-fir Tussock Moth, Orgyia pseudotsugata (McDunough) is an important defoliator of true firs and Douglas-fir in Western North America. Outbreaks develop rapidly and then usually subside after a year or two, usually lasting for a total of 4 years. During outbreaks, defoliation can be severe.

Biology and Life Cycle

In the Southwest the tussock moth has two hosts, white fir and Douglas-fir. White fir is the preferred host in this region. Though its name may seem a misnomer in this area, Douglas-fir is the preferred host in the northern part of its range in British Columbia and northern Washington.

The tussock moth produces one generation per year. Adults appear from late July into November. While males fly, females moths are flightless and have only rudimentary wings. The female attracts males by emitting a sex pheromone.

After mating she lays an egg mass which is coated with hairs. Eggs hatch in late May or early June, coinciding with bud burst and shoot elongation of host trees. Larvae then crawl to the new needle growth and begin feeding. Larvae grow and feed, passing through 6 instars before pupating in July. Dispersal occurs during the larval stage when young larvae can be carried by the wind.

Many natural controls exist that usually keep populations at low levels. These include insect parasites and predators, and birds. At outbreak levels, a nuclear polyhedrosis virus, along with the other mortality factors, causes collapse of tussock moth populations.

Effects

The direct effect of larval feeding is defoliation. The insect prefers to feed on the current years foliage, however during outbreaks, both current foliage, older foliage, and even foliage of other trees and shrubs may be consumed. Heavy defoliation can result in both outright tree mortality and top-killing. In an outbreak in eastern Oregon and Washington, 39 percent of all trees were killed in heavily defoliated areas. Top-kill in these areas amounted to between 10 and 33 percent of the trees, depending on species. Growth is retarded for several years.

Ecosystem level effects of defoliation and tree mortality are many. Defoliation and tree mortality can lead to reductions in transpiration and consequently reduced soil water depletion in the short term. Streamflows can be increased after heavy defoliation. Nutrient distribution and availability can be altered. Forest plant species composition can be altered both directly and indirectly. Direct effects occur as a result of tree mortality and can result in species shifts towards non host tree species. Indirect effects result from environmental changes which occur following defoliation and can also result in altered plant species composition.

ACKNOWLEDGEMENTS

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Wickman, B.E., R.R. Mason, and G.C. Trostle. 1981. Douglas-fir Tussock Moth USDA Forest Service, Forest Insect and Disease Leaflet 86. 10 p.

FIGURE 1

FORM FOR SEQUENTIAL SAMPLING OF TUSSOCK MOTH LARVAE

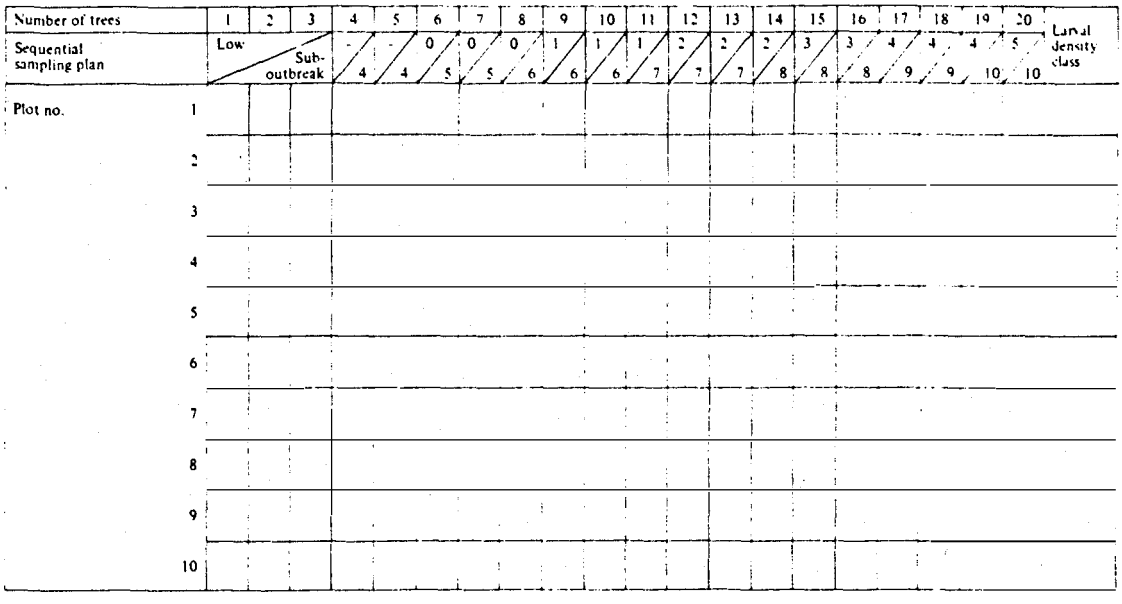
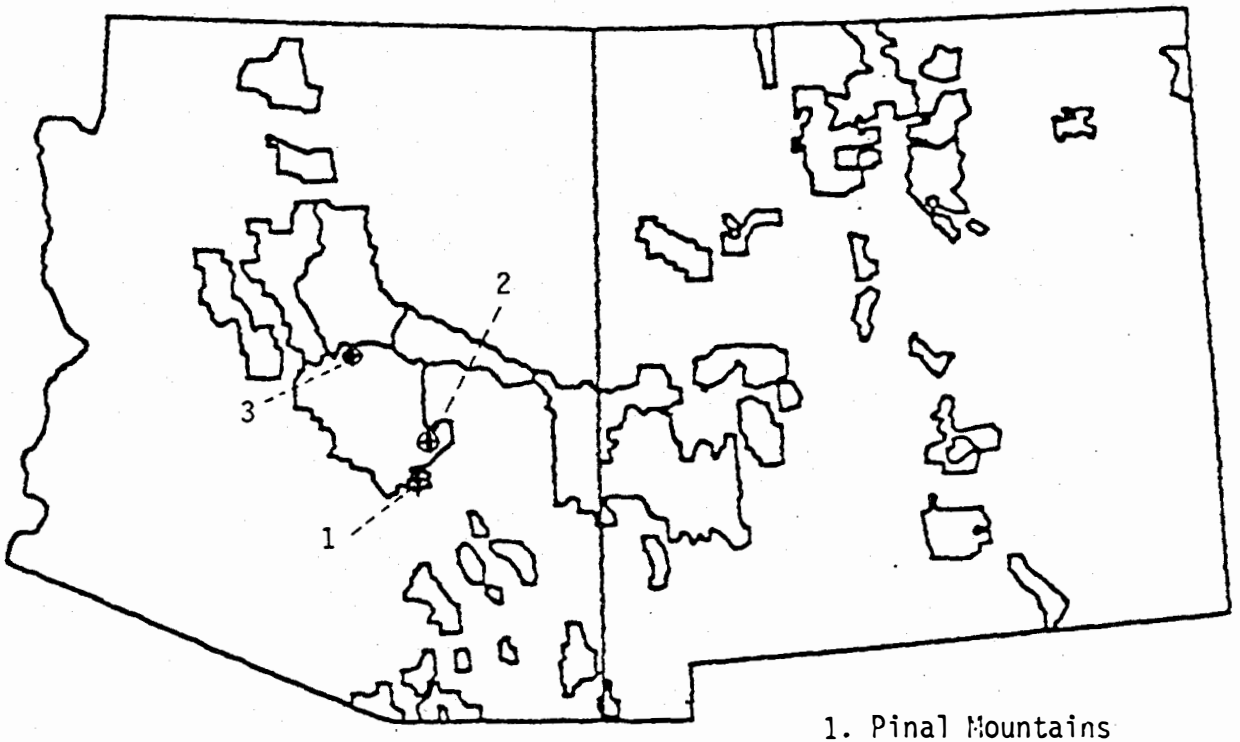


FIGURE 2

DFTM OUTBREAK EARLY WARNING
DETECTION SYSTEM SITES IN
ARIZONA, 1992



1. Pinal Mountains
2. Sierra Ancha Mountains
3. Mogollon Rim

FIGURE 3

1993 DFTM PHEROMONE TRAP PLOTS
PINAL MOUNTAINS

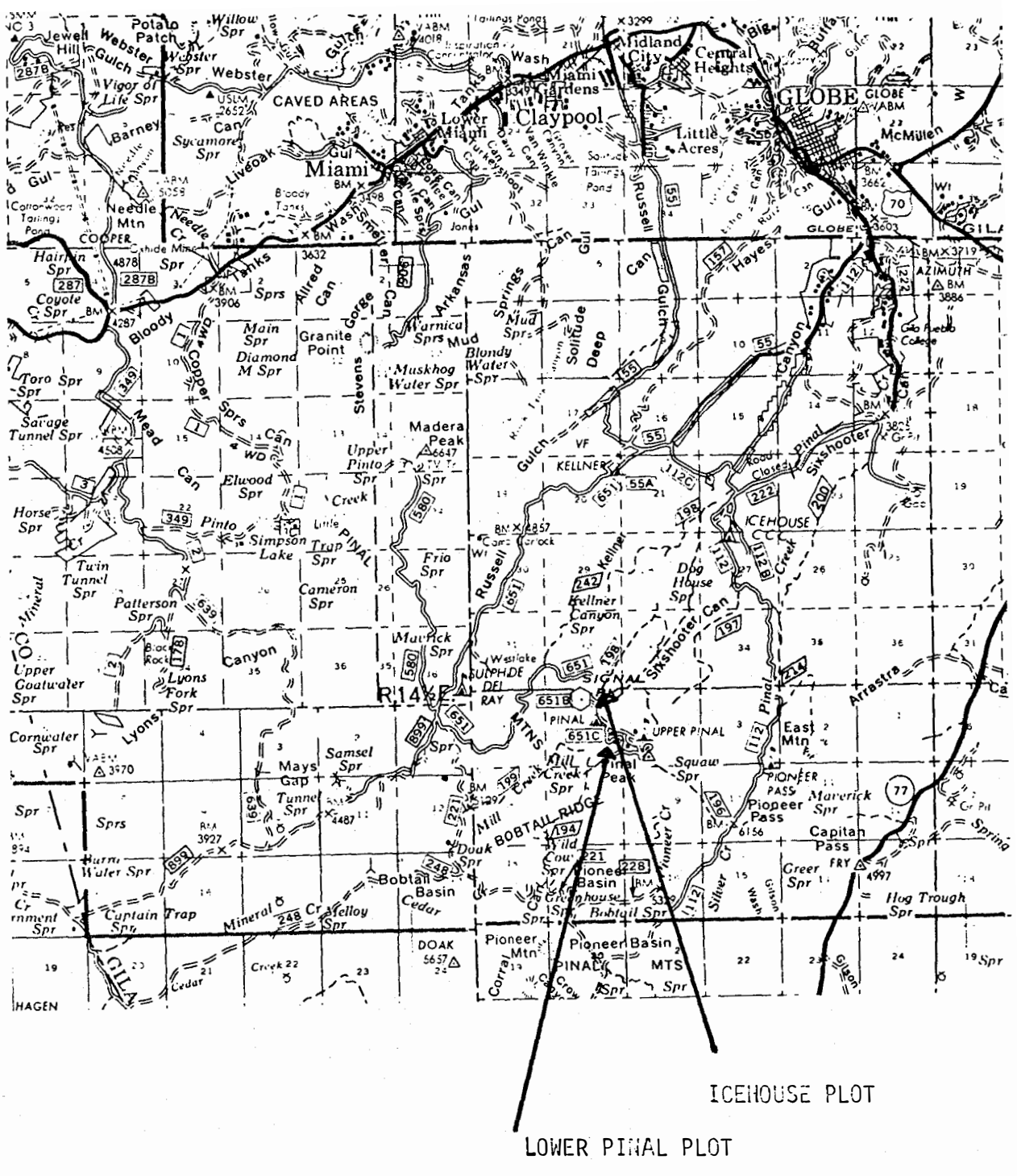


FIGURE 4

1993 DFTM Pheromone Trap Plots
Sierra Ancha Mountains

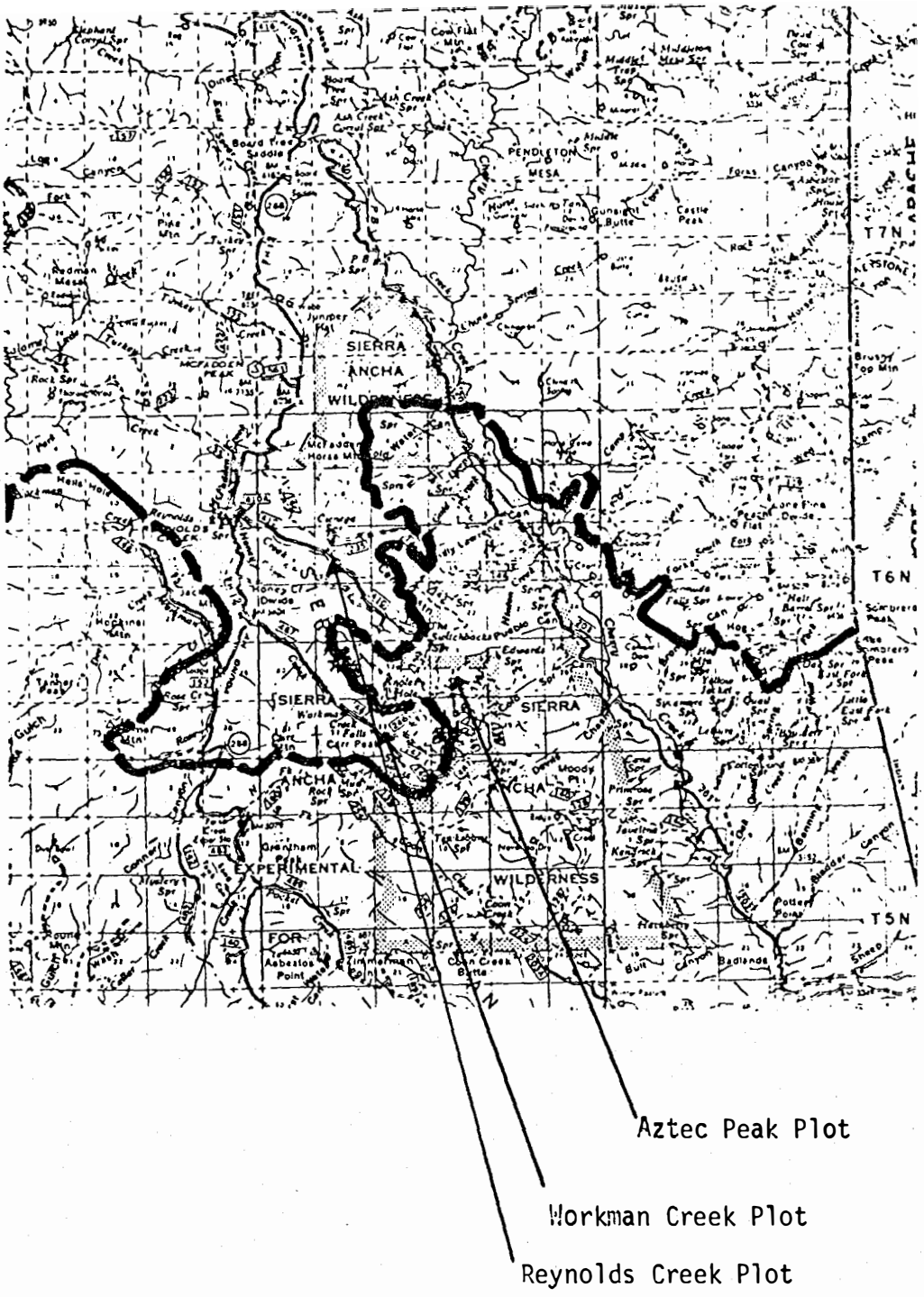


FIGURE 4

1993 DFTM Pheromone Trap Plots
Sierra Ancha Mountains

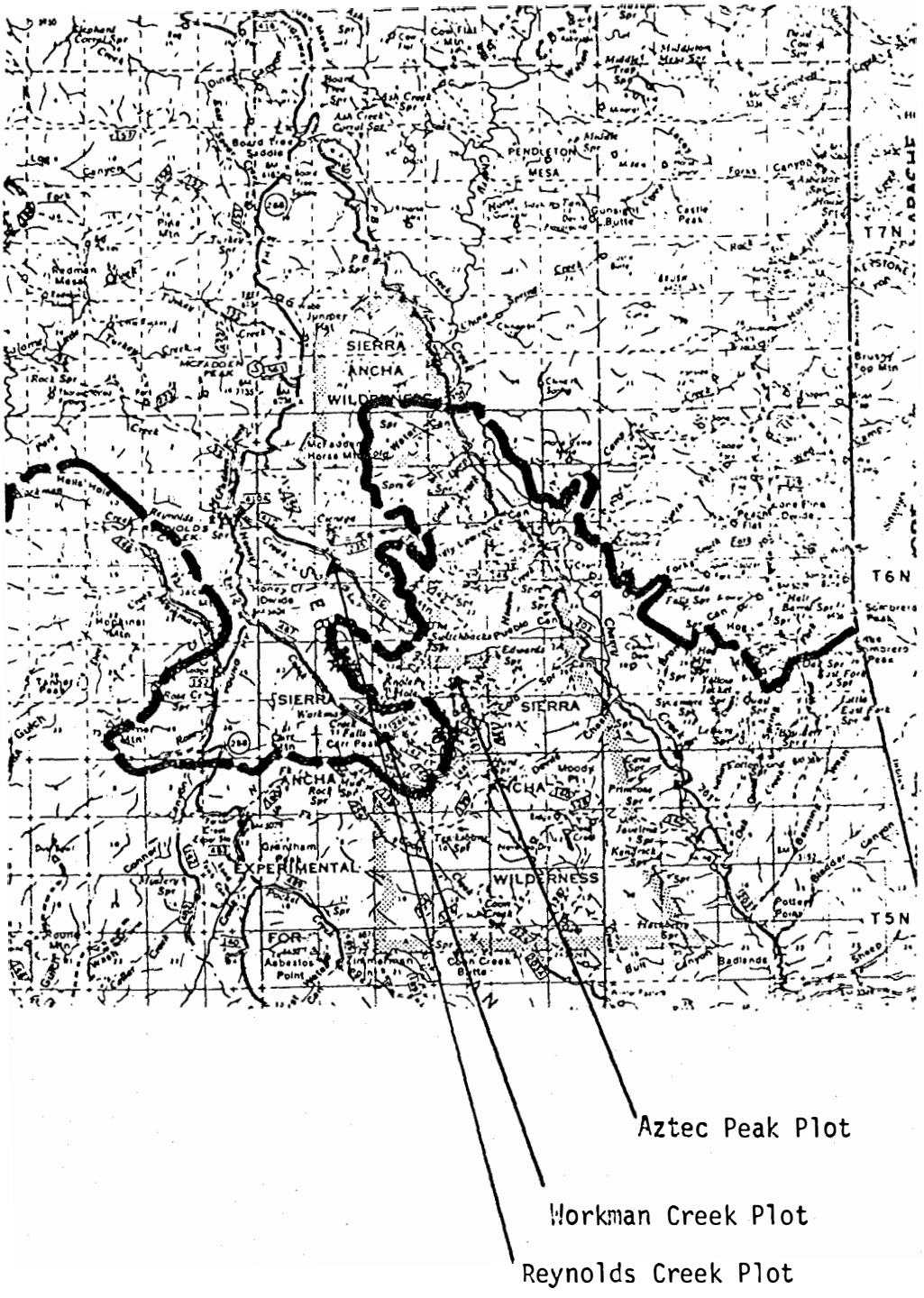


FIGURE 5

1993 DFTM Pheromone Trap Plots
Mogollon Rim